The Powder Coating Institute
presents

INTRODUCTION TO POWDER COATING

The Contents of the Program

- Introduction & Program Overview
- Pretreatment & Substrates
- Powder Coating Materials & Application
- Curing, Quality Testing, & Packaging
- Materials Handling, Process Control, Tracking & Recording
- Safety Issues, OSHA, & Environmental Concerns

Performance Goals - Understand These Issues:

- The Powder Process
- The Powder System Components
- Powder Materials
- Application Equipment & Controls
- Performance Testing & Quality Control
- Safety Issues

How We Got Started In Powder Coating

- The Beginning
- Our Progress
- Future Plans

The History of Powder Coating

- Late 1940s: Flame Spray of Thermoplastic Powder
- 1953: Fluidized Bed Application
- 1962 - 1964: Electrostatic Spray Application Introduced
- 1966 - 1973: Introduction of Four Original Thermoset Powders
- 1970s - today: Rapid Growth of Powder Industry

The Basics of the Powder Coating Process

- Fluidized Bed Application Process
- Electrostatic Spray Application Process

Fluidized Bed Application

- Parts are Cleaned
  - Washed & Phosphated or Blasted & Primed
- Parts are Preheated to 400^0 F or Higher
- Hot Part is Dipped Into the Fluidized Powder
- Powder Particles Melt & Fuse on the Hot Metal
- Parts are Post-Cured

Electrostatic Spray Application

- Parts are Cleaned & Pretreated
- Powder is Charged & Sprayed onto the Grounded Part
- Part is Transferred into an Oven to Melt and Crosslink the Powder

PRETREATMENT & SUBSTRATES

Pretreatment

- Cleaning
- Conversion Coating
- Rinsing

Why Clean?

- Appearance
- Adhesion
- Corrosion Resistance

Cleaning Methods

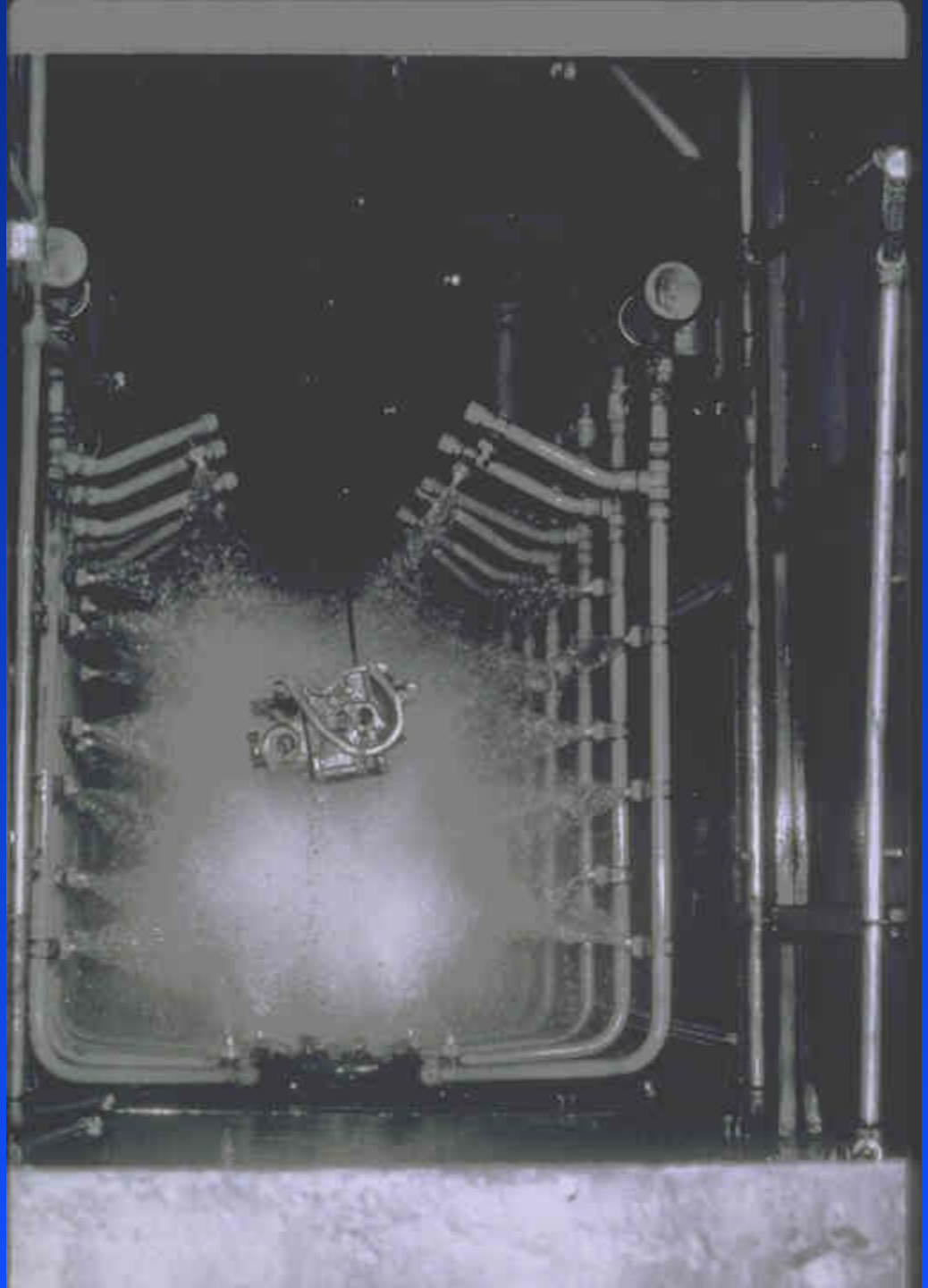
- Mechanical
  - Polishing
  - Blasting
- Chemical
  - Dip
  - Spray

Mechanical Cleaning

- Removes
  - Mill Scale
  - Rust
  - Smut
  - Die Release Contamination

Chemical Cleaning

- Removes
  - Oil
  - Shop Dust
  - Grease
  - Rust Inhibitors



Cleaner Types

- Acidic - pH of 4.0 to 5.5
- Alkaline - pH of 9 to 10.5

Conversion Coating

- Iron Phosphate
- Zinc Phosphate

Iron Phosphate

- Most Common for Powder Coating
- 35 to 45 mg/sq. ft.Typ. Coating Weight
- Amorphous Surface Structure
  - (no apparent crystalline form)
- Good Adhesion
- Modest Corrosion Resistance
- Moderate Sludge Formation

Zinc Phosphate

- Not Commonly Used for Powder Coating
- 60 to 120 mg/sq.ft. Typ. Coating Wght.
- Crystalline Surface Structure
- Very Good Adhesion
- Very Good Corrosion Resistance
- Heavy Sludge Formation

Rinsing

- Between Chemical Processes
  - To Remove Residual Chemistry
- Final Rinse/Seal
  - To Passive the Surface
- Dionized Rinsing
  - Pure Water to Remove Residual Salts

3-Stage Spray Washer

- Stage 1- Cleaner/Coater: 90 secs., 140^0 F
- Stage 2- Rinse: 30 secs., Ambient
- Stage 3- Rinse/Seal: 30 secs., 120^0 F

5-Stage Spray Washer

- Stage 1- Alkaline Clean: 90 secs.,140^0 F
- Stage 2- Rinse: 60 secs., Ambient
- Stage 3- Iron Phos.: 60 secs. 140^0 F
- Stage 4- Rinse: 30-60 secs. Ambient
- Stage 5- Rinse/Seal: 30 secs. 120^0 F

Substrates

- Steel
  - Cold Rolled Steel
  - Hot Rolled Steel
- Aluminum Extrusion
- Galvanized
- Castings
  - Aluminum
  - Zinc

Pretreatment Problems

- Poor Adhesion
- Blisters
- Surface Defects
- Poor Corrosion Resistance

Pretreatment Control

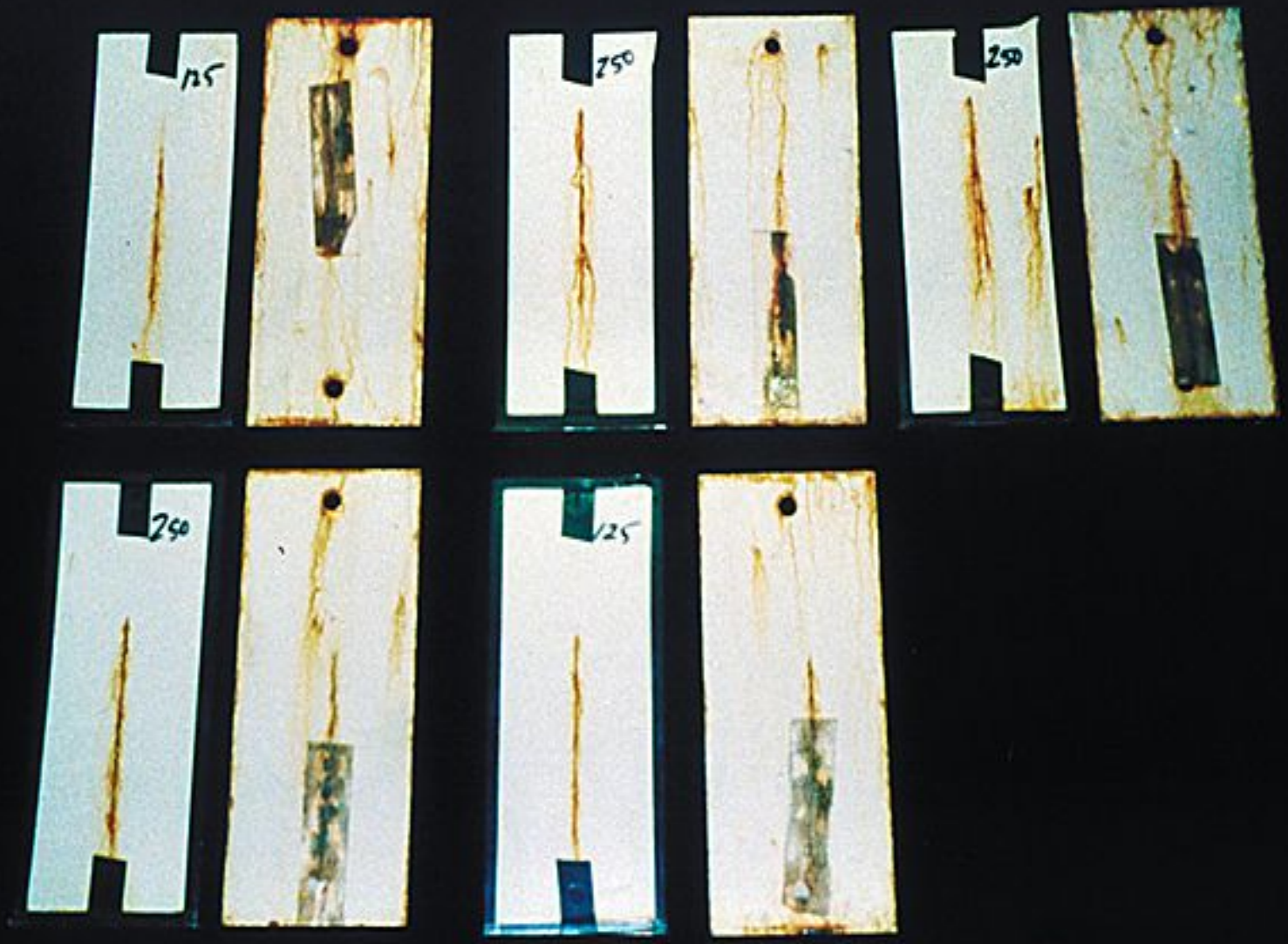
- Check Solution Concentration 3 times per shift
- Keep the Washer Nozzles & Pump Screens Clean
- Maintain Clean Rinse Water

Pretreatment Tests

- Water Break Free
- Adhesion Test
- Coating Weight
- Humidity Test
- Salt Spray Test


Humidity
200


SALT SPRAY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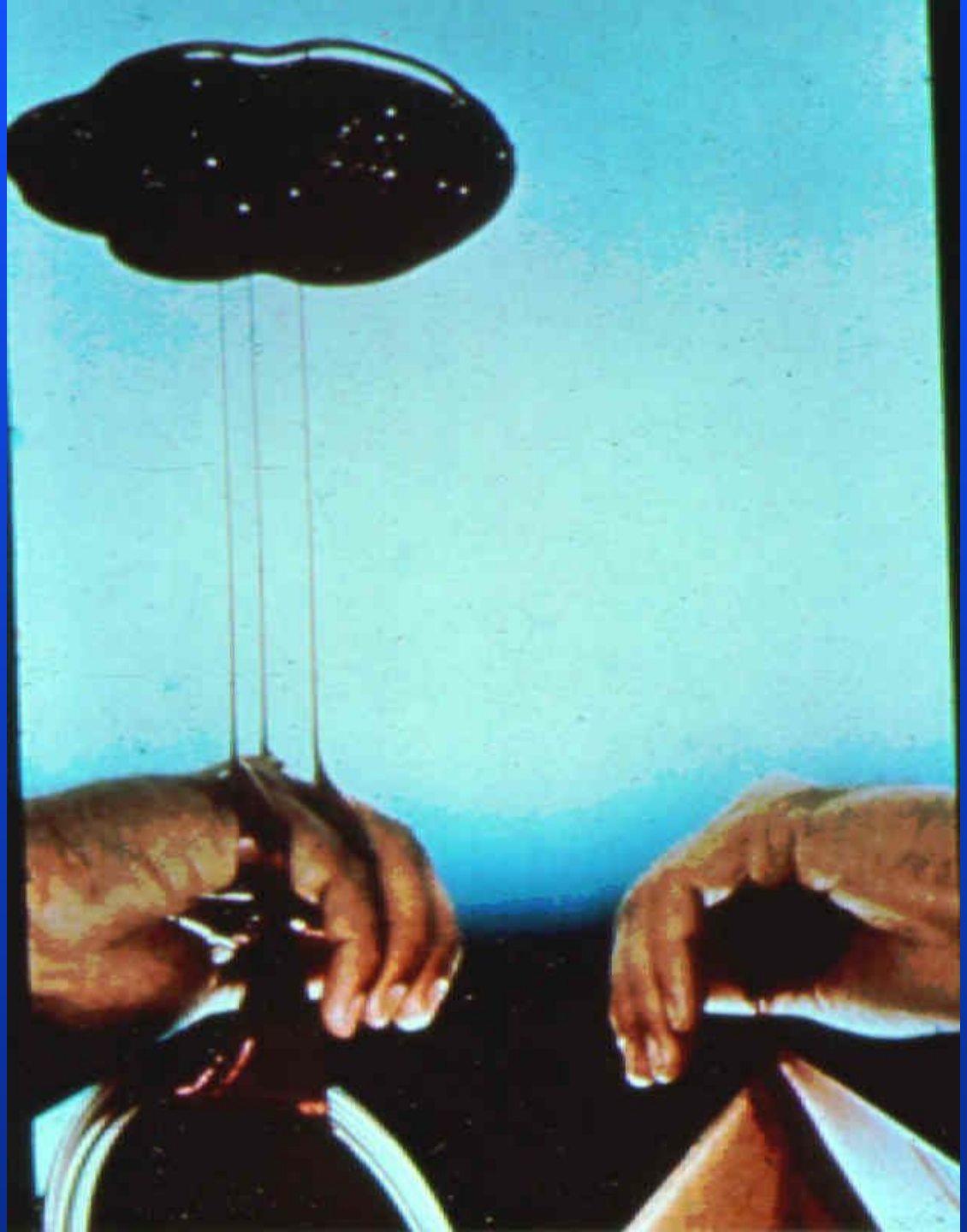
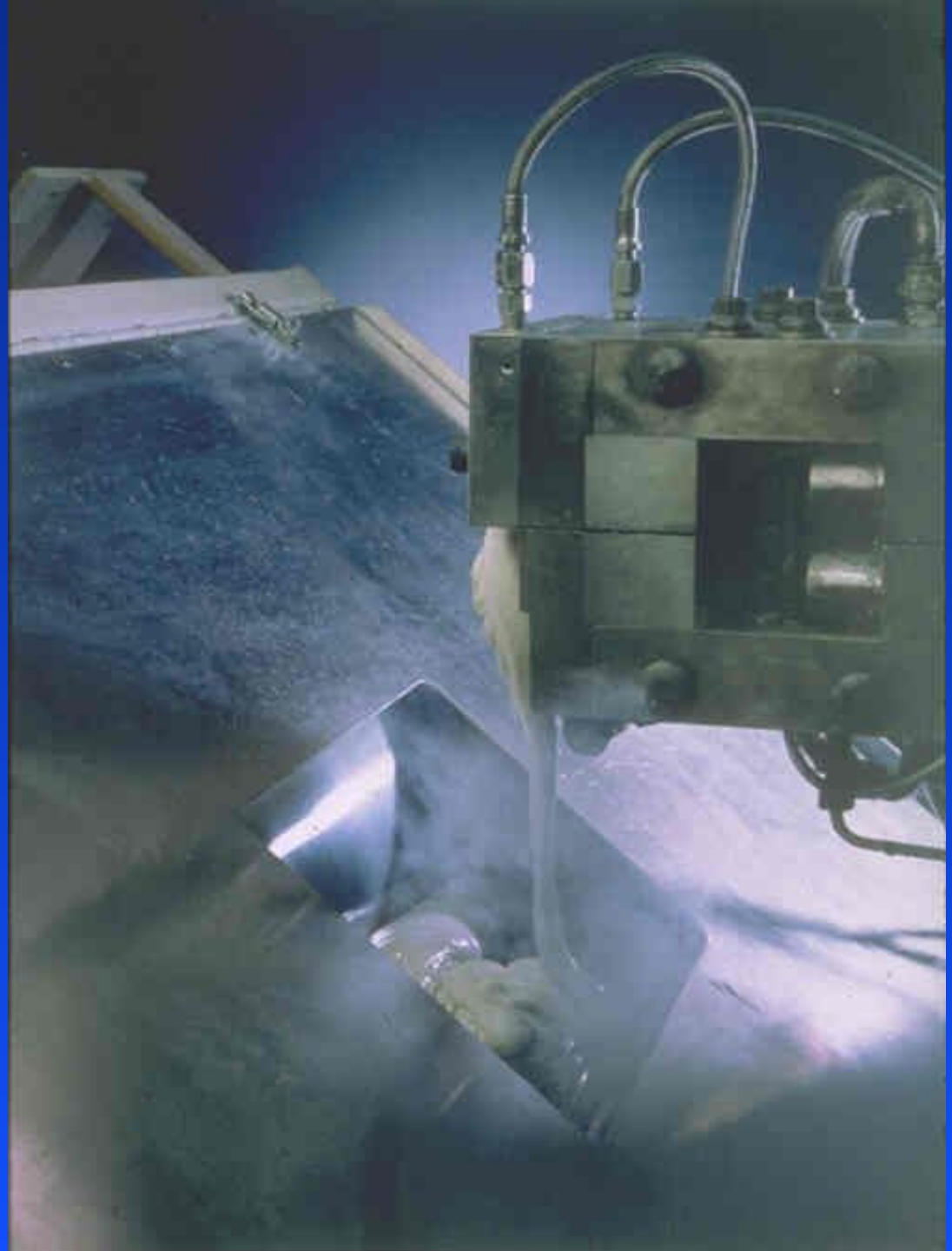
POWDER COATING MATERIALS



Powder Material Components

- Resins
- Pigments
- Cure Agents
- Flow Agents
- Additives

RESINS PLUS PIGMENTS/ADDITIVES



Two Types of Powder Materials

- Thermoplastic
  - do not chemically react during cure
- Thermoset
  - chemically react during cure

Thermoplastic Resins

- Nylon
- Polyethylene & Polypropylene
- Polyvinyl Chloride (PVC)
- Polyester
- Poly(Vinylidene Fluoride)(PVFD)

Thermoset Powders

- Epoxies
- Urethane Polyesters
- TGIC Polyesters
- Hybrids
- Acrylics

POWDER APPLICATION METHODS

- Fluidized Bed Dip
- Electrostatic Spray

Fluidized Bed Dip

- Preheated Part is Dipped into Fluidized Powder; Powder Gels on Hot Surface
- Used for Application of Thermoplastic Materials

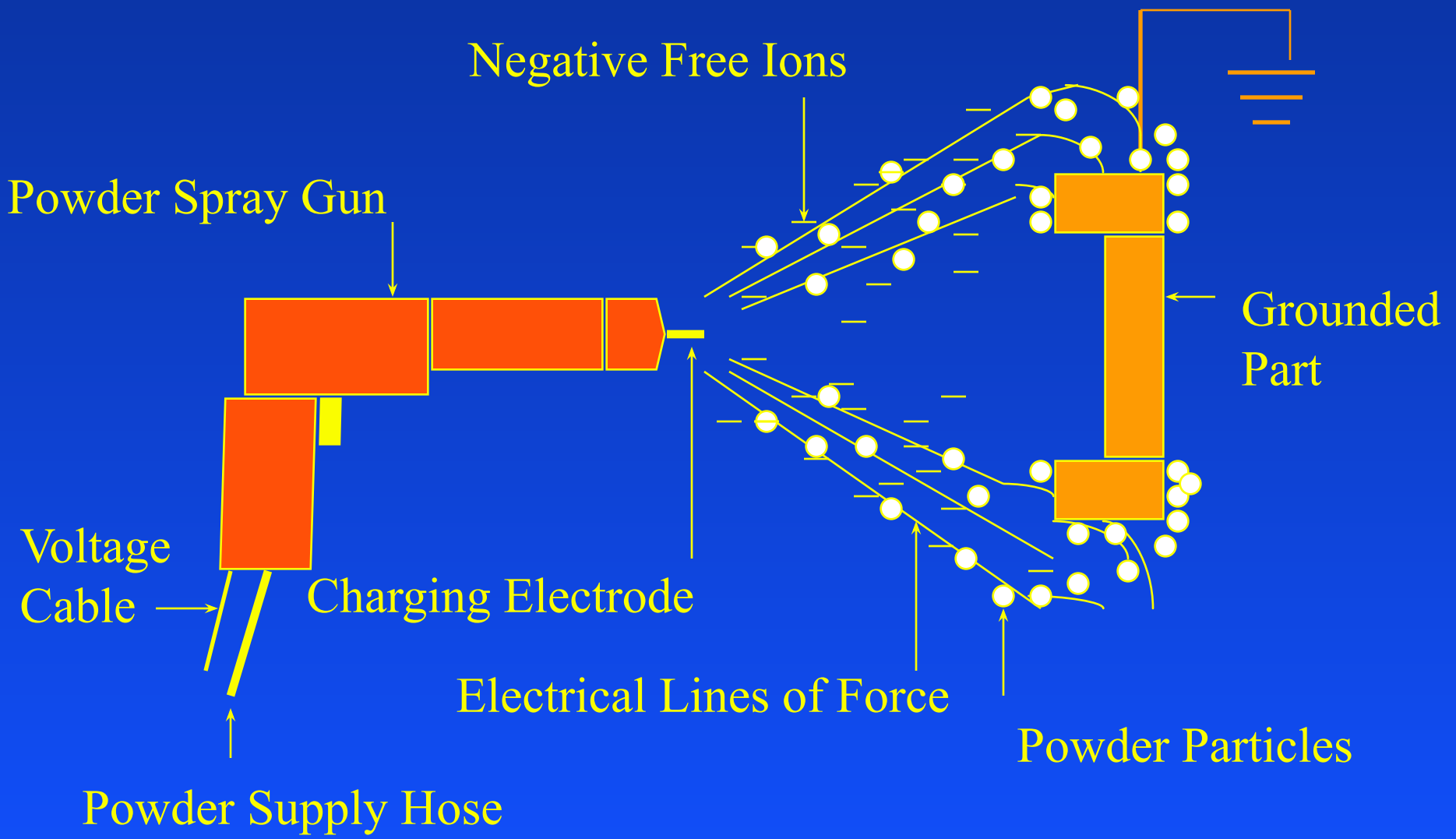
Electrostatic Spray

- Charged Powder Material is Sprayed onto Grounded Part
- Parts are Subjected to High Temperature to Crosslink
- Used for Application of Thermoset and Sometimes Thermoplastic Materials

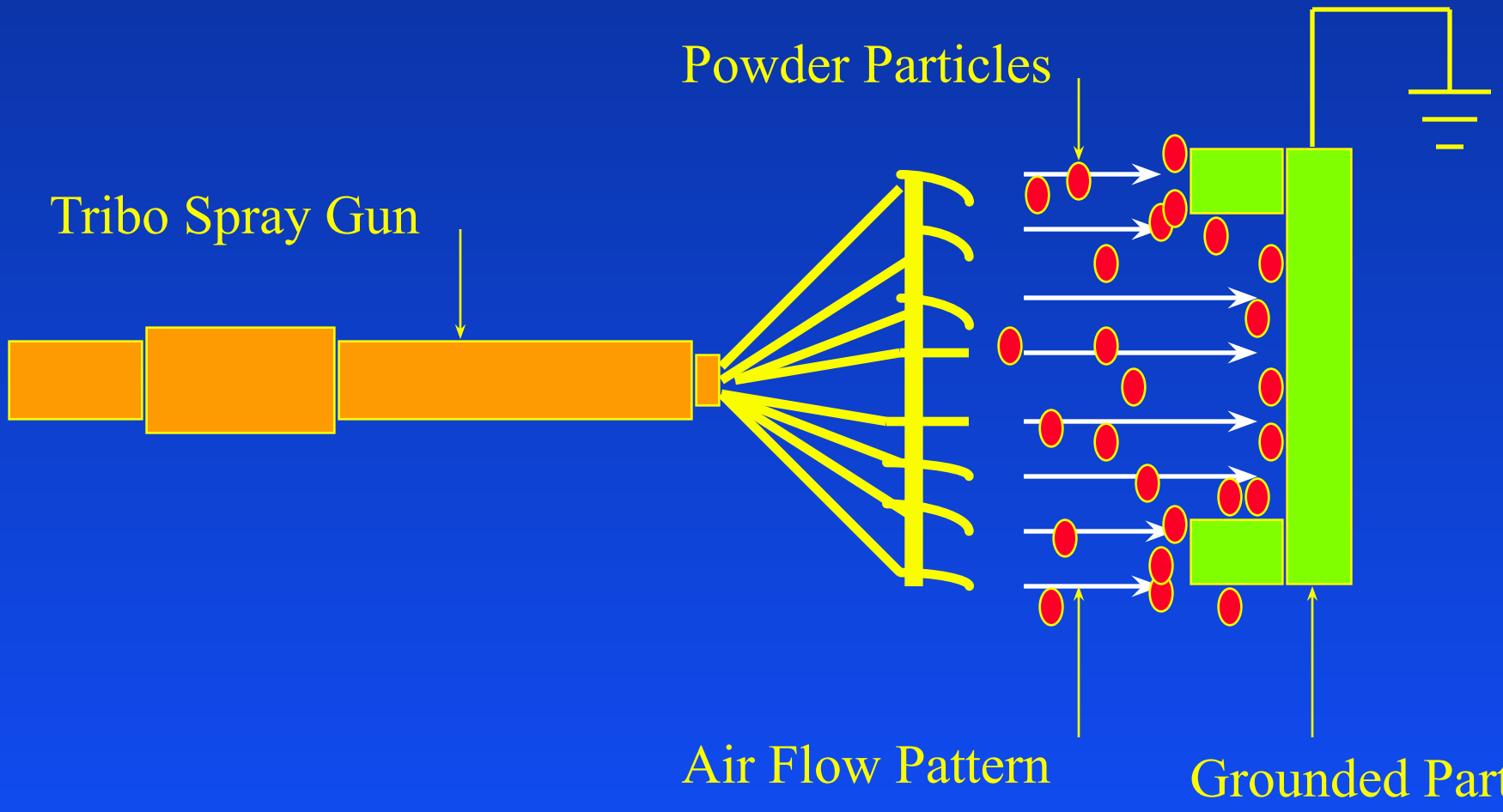
Charging Methods for Electrostatic Spray

- Corona Charging
  - Uses High Voltage & an Electrode
- Tribo Charging
  - Uses Frictional Contact With the Gun Interior Wall

Corona Charging



Tribo Charging



The Powder Delivery System

- Fluid Bed Hopper
- Powder Pump
- Powder Hose
- Spray Gun

Compressed Air Supply

- $+38^{0}$F Dew Point or Lower
- Less than 0.1 PPM of Oil
- No Particle Greater than 0.3 Micron

The Corona Charging System

- Voltage Supply
- High Voltage Generator
- Voltage Cable
- Electrode

Pneumatic Controls

- Fluidizing Air
- Powder Supply Air
- Atomizing Air
- Cleansing or Shaping Air

Delivery Pressure & Transfer Efficiency

- Powder Charges Better at Lower Pressure
- Transfer Efficiency is Higher at Lower Pressure

Voltage Control

- 80 to 100 KV
  - Used for Most Surfaces
- Lower Voltage
  - Used for Faraday Cage Areas & Recoats

Transfer Efficiency Variables

- Nozzle Type
- Powder Delivery Rate
- Gun Position
- Grounding
- The Powder Material
- System Maintenance & Control

BOOTHS & RECOVERY SYSTEMS

- Booth is Used to Enclose Process & Contain Overspray
- Recovery System is Used to Capture Overspray

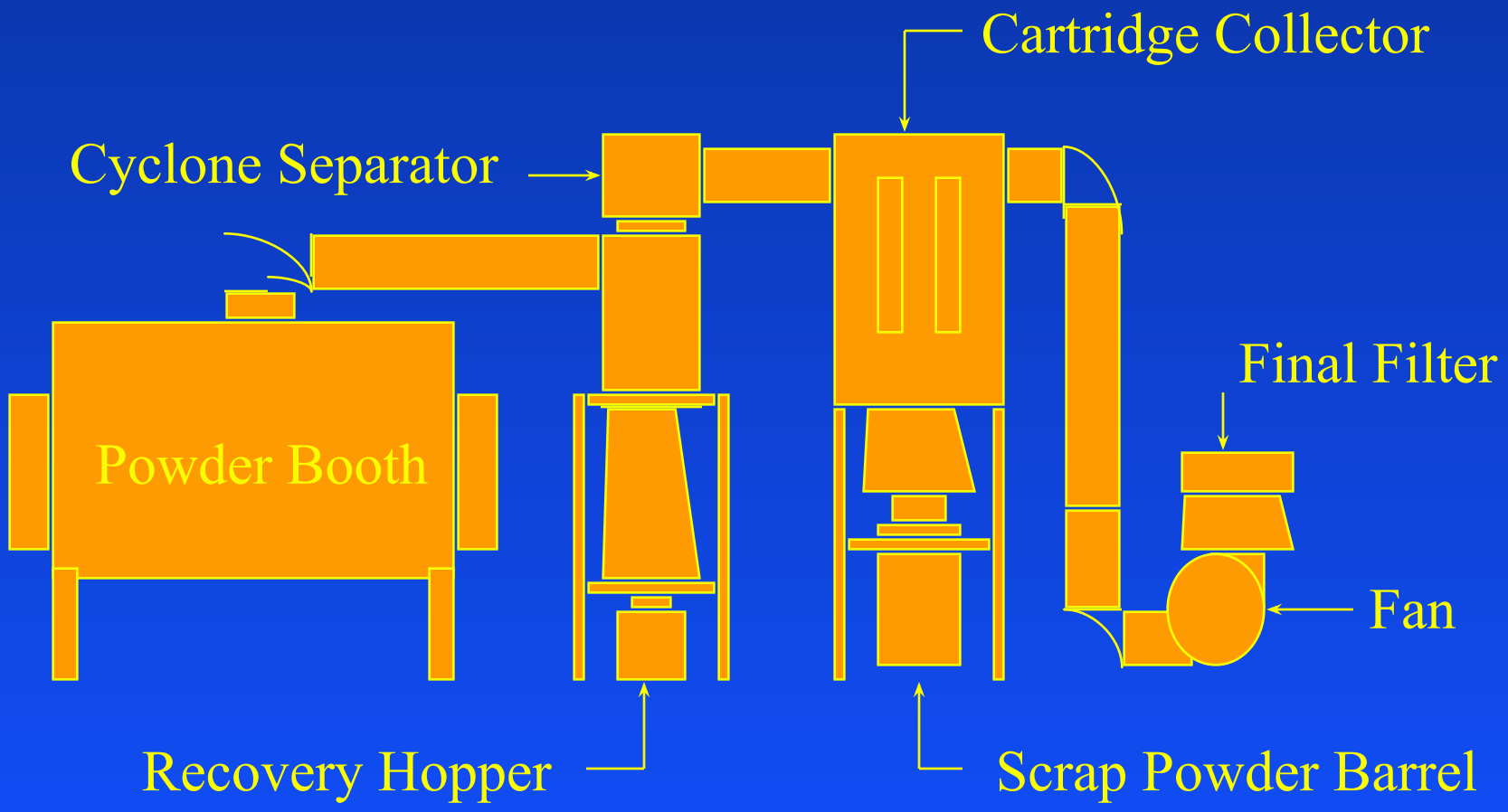
Types of Booths

- Batch Booths
- Conveyorized Systems

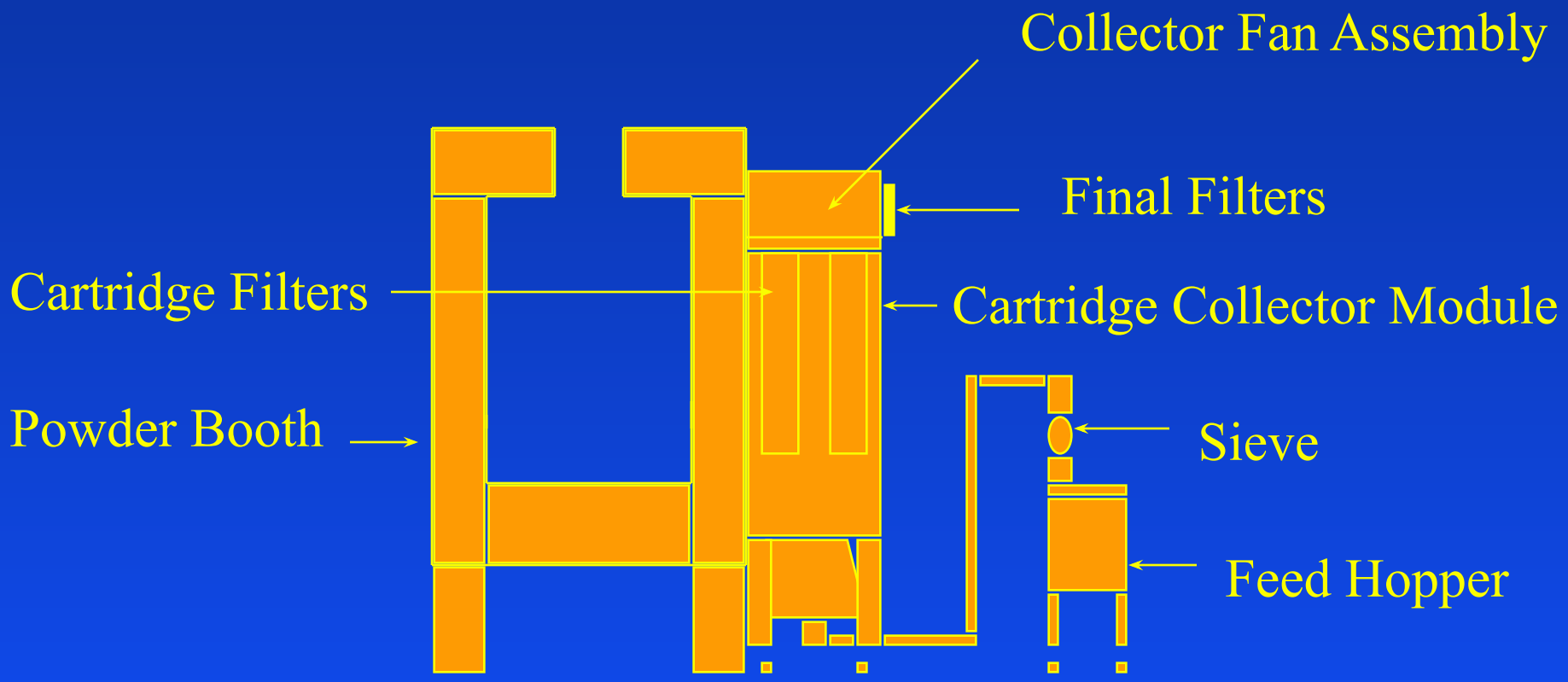
Two Common Types of Recovery Equipment

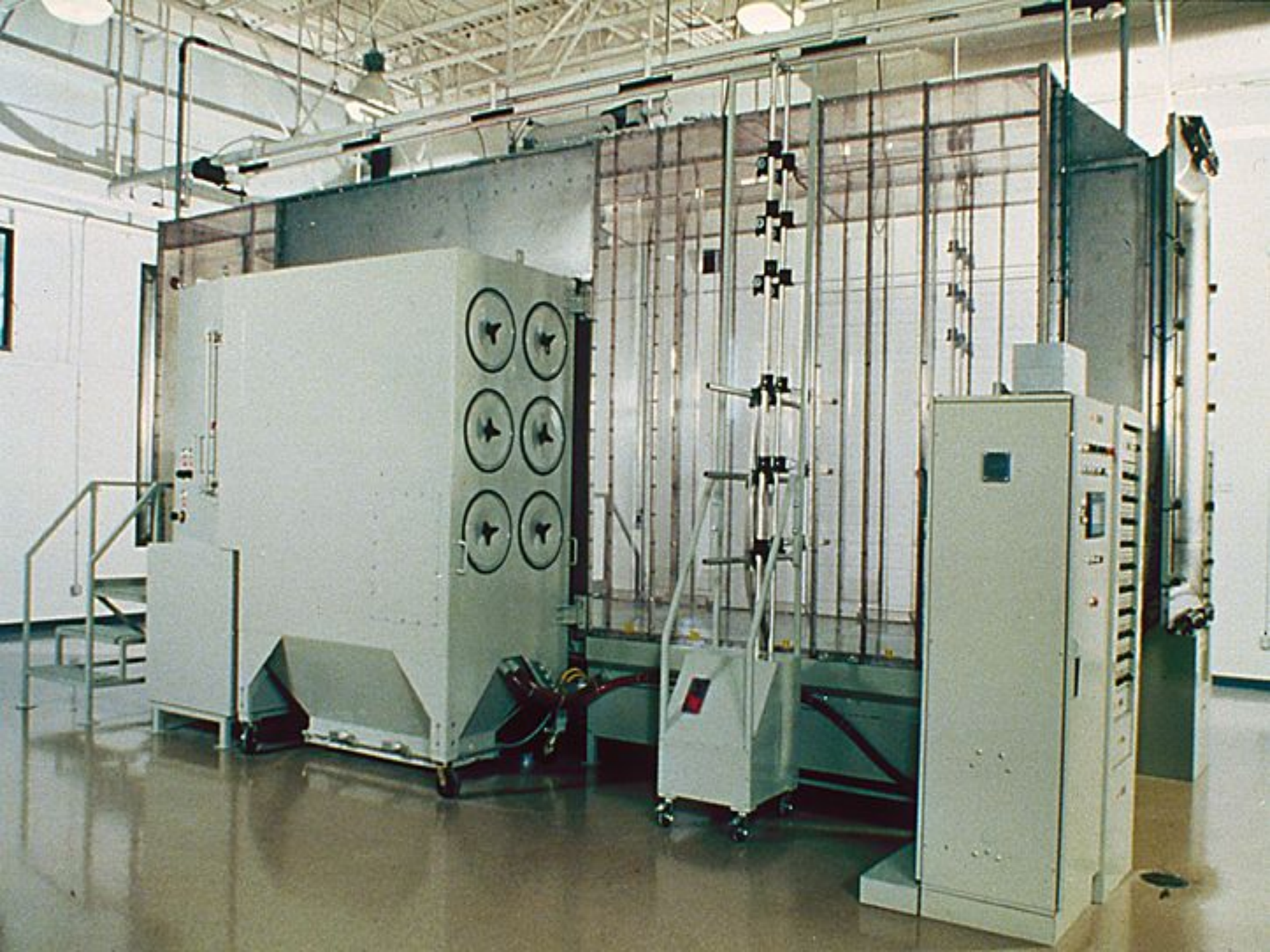
- Cyclone System
- Cartridge Module System

Booth & Cyclone Recovery System



Cartridge Module System






BINKS

Spray to Waste

- Short Runs of Various Colors
  - Faster Color Change Time
  - Higher Material Cost

Reclaiming Powder for Reuse

- Collect Overspray for Reuse
  - Long Runs of the Same Color
- Mix Reclaim & Virgin Material Consistantly

CURING, TESTING, QUALITY CONTROL & PACKAGING

Powder Coating Cure Cycle

- Enters the Oven Dry
- Melts & Flows From Heat
- Gels & Chemically Crosslinks
- Exits the Oven as a Hard Film

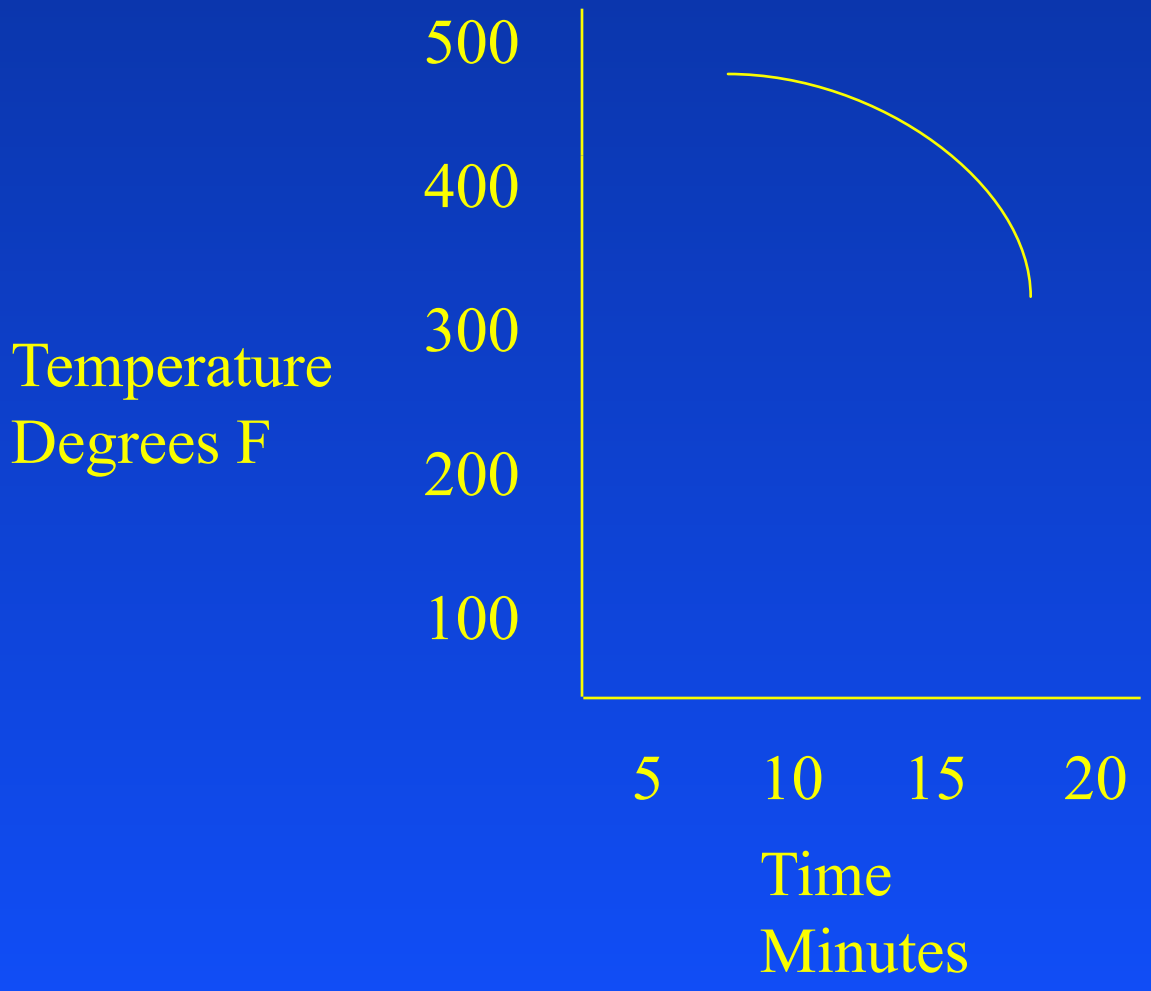
Cure Methods

- Convection
- Infrared

Convection Oven

- Hot Air is Used to Heat Substrate
- Heated Substrate Conducts Heat to Coating
- Temperature is Held for Specific Length of Time to Reach Full Cure

Cure Curve for Powder Coating



Infrared Cure

- Energy is Emitted & Directed to Part
- Energy Absorbed into Coating & Part Surface Causes Quick Crosslinking

Convection Cure

- Advantages
  - More Flexible for Part Mass & Surface Variety With Little Required Adjustment
  - More Consistent Outcome with a Broader Range of Process Control Variables
- Limitations
  - Requires More Space
  - Longer Cycle Time

Infrared Cure

- Advantages
  - Faster Cure Cycle
- Limitations
  - Dependent on Line-of-Sight
  - Less Flexible for Part Mass & Surface Variety With More Adjustment Required

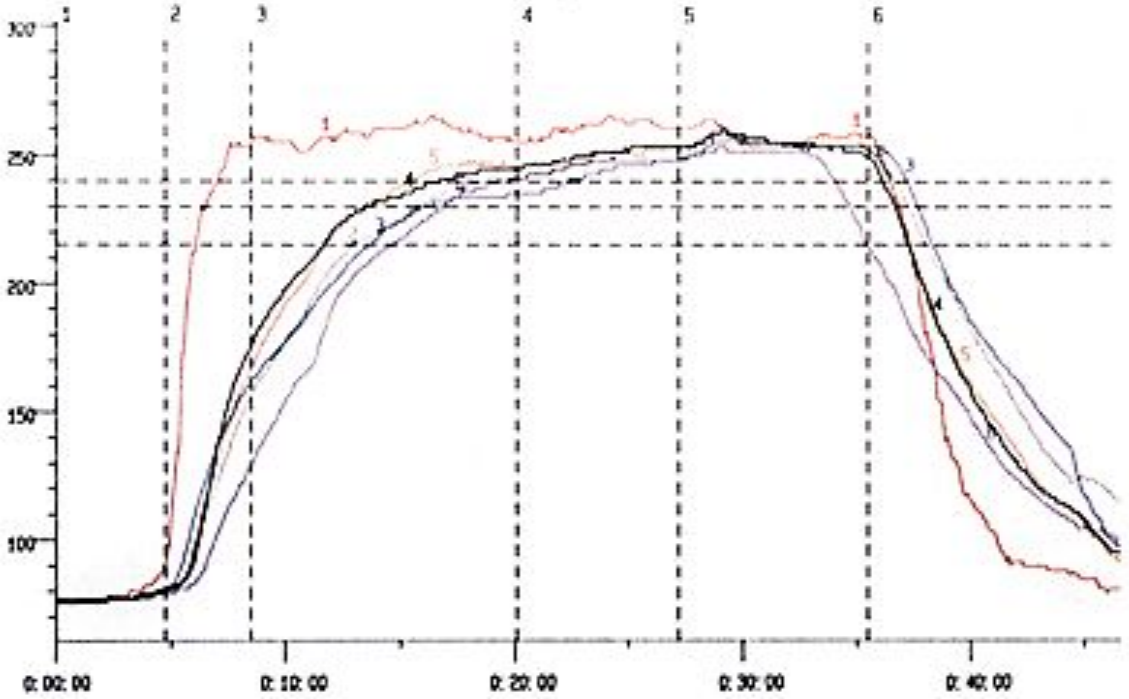
Testing & Quality Control

- Test Oven for Temperature Uniformity
- Test Washer Chemistry
- Test Finished Film Properties

DATAPAQ Oven Tracker Elite: Standard Report on Hewlett Packard Plotter

DATAPAQ INC MILMINGTON MA	Oven : West Topcoat	Report Date : 10/24/1991
Site: Plant 1	Product: A Body	Line Speed : 48 DPH

Temperature (F) against Time (hrs)



Run Information

Pagfile : Automotive 1
Operator : M. White
Cycle Time : 36 Min.
Transducer Id : A611-60-01
Number of Probes : 6
Sampling Interval : 0:00:05
Trigger Deselected
Uploaded at : 15:02:00 on 10/14/88
Paq reset : 13:41:00 on 10/14/88

Comments

You can enter up to 10 lines of information in this space.
i.e. Coating type; Zone settings comments on runs, ect.
Note undercure of rocker inside panel, w/Index of cure at only 89.

For more information call Datapaq at (508) 988-9000.

WARNING : Probe(s) 1, 4 exceeded max temp.

Datapaq Value by zone							Probes	Datapaq Value Threshold Calculations					Peak		Probe Map
Zone Number							Temp	MIN: 210	LOW: 215	MID: 230	HI : 240	MAX: 260	Temp	Time	
1	2	3	4	5	6	Overall	Time		0:45:00	0:36:00	0:28:00			reached	
0	10	72	47	50	7	189	1 AMBIENT	0:31:35	0:31:15	0:30:30	0:29:25	0:11:15	266	0:16:20	
0	0	22	31	46	9	110	2 ROOF THIN METAL	0:26:05	0:25:05	0:21:40	0:17:25	0:00:00	257	0:28:40	
0	0	19	27	42	12	101	3 DOOR MED. METAL	0:25:45	0:24:45	0:21:55	0:14:55	0:00:00	253	0:28:50	
0	0	28	34	47	6	117	4 ROCKER THICK METAL	0:26:25	0:25:40	0:23:20	0:19:25	0:00:10	261	0:29:05	
0	0	31	34	47	7	121	5 QUARTER PANNEL MED. METAL	0:26:20	0:25:50	0:23:45	0:21:10	0:00:00	259	0:28:45	
0	0	17	30	40	0	89	6 ROCKER INSIDE	0:22:10	0:20:50	0:17:55	0:14:15	0:00:00	257	0:29:25	


125
100

Finished Film Tests

- Color & Gloss
- Film Thickness
- Adhesion
- Pencil Hardness
- Impact Resistance
- Chemical Rub Test

Packaging

- Protect the Surface After Coating
- Keep Good Records of Packed Product
- Control the Volume per Skid
- Take Account of any Special Costs

Packaging Materials

- Boxes
- Paper
- Foam
- Plastic Bags
- Cardboard Dividers
- Shrink Wrap
- Banding

Types of Packaging

- Bulk Containers
- Layer Packing
- Layer Packing with Wrap
- Weave Packing
- Cell Packing
- Stacking

OPERATIONS - MATERIALS HANDLING, PROCESS CONTROL, TRACKING & RECORDING

Material Handling

- Purchasing Materials
- Storage of Materials
- Inventory Control
- Material Supply

Powder Purchasing Considerations

- Purchase Just Enough to Support Production
- Avoid Long-Term Storage

Powder Storage

- Maintain Temperature as Low as Possible
  - Below 80^0 F Preferred
- Maintain Humidity as Low as Possible
  - Below 60%Preferred
- Do Not Stack More Than 3 Boxes High
- First in, First out

Powder Supply

- Sieve or Screen all Powder
- Precondition Powder by Fluidizing
- Mix Enough Virgin Material with Reclaim To Remain Efficient
  - 50/50 Typical
- Close Up Containers in Storage

Pretreatment Chemicals

- Additions to Washer
  - Manual or Automatic
- Handling
  - Use Proper Safety Precautions
- Storage
  - Indoors, Dry Conditions

PROCESS CONTROL

- Application Control
- System Monitoring & Maintenance

System Monitoring & Maintenance

- Training to Maintain Worker Skills
- Proper Management of Raw Materials
- Housekeeping & Control of the Environment
- Maintenance of the Equipment

Equipment Maintenance

- Spray Washer - titrate solutions, clean nozzles, clean screens
- Dry-off Oven - keep oven clean
- Application Equipment - keep clean, replace worn parts
- Cure Oven - keep oven clean

Equipment Maintenance (Continued)

- Booth & Recovery System - keep clean, check filters, clean sieve
- Conveyor - keep clean, lubricate
- Racks & Hangers - keep contacts & frame clean & in good repair

TRACKING & RECORDING COATING JOBS

- Control of Inventory From Arrival to Shipment
- Work in Process Records

Receiving

- Enter into Inventory
- Notify Customer of Mistakes
- Store in Consistent Location
- Isolate one Batch from Others

Processing

- Verify Proper Count When Loading
- Separate & Count Rejects
- Maintain Counts With Progress
  - raw parts
  - coated, not inspected
  - ready for shipment
  - rejects

Rework

- Schedule for Quick Turn-around
- Maintain Status Report
- Count Parts that Cannot be Salvaged

Status

- Be Able to Inform Customer on Progress
  - parts raw
  - parts coated
  - parts ready for shipment
  - parts to be reworked
  - parts that have flaws that cannot be fixed

SAFETY ISSUES, OSHA, & ENVIRONMENTAL CONCERNS

Handling of Powder Coatings

- Read the MSDS
- Avoid Excess Skin Exposure
- Wear the Proper Respiratory Equipment
- Wear the Proper Clothing & Eyewear

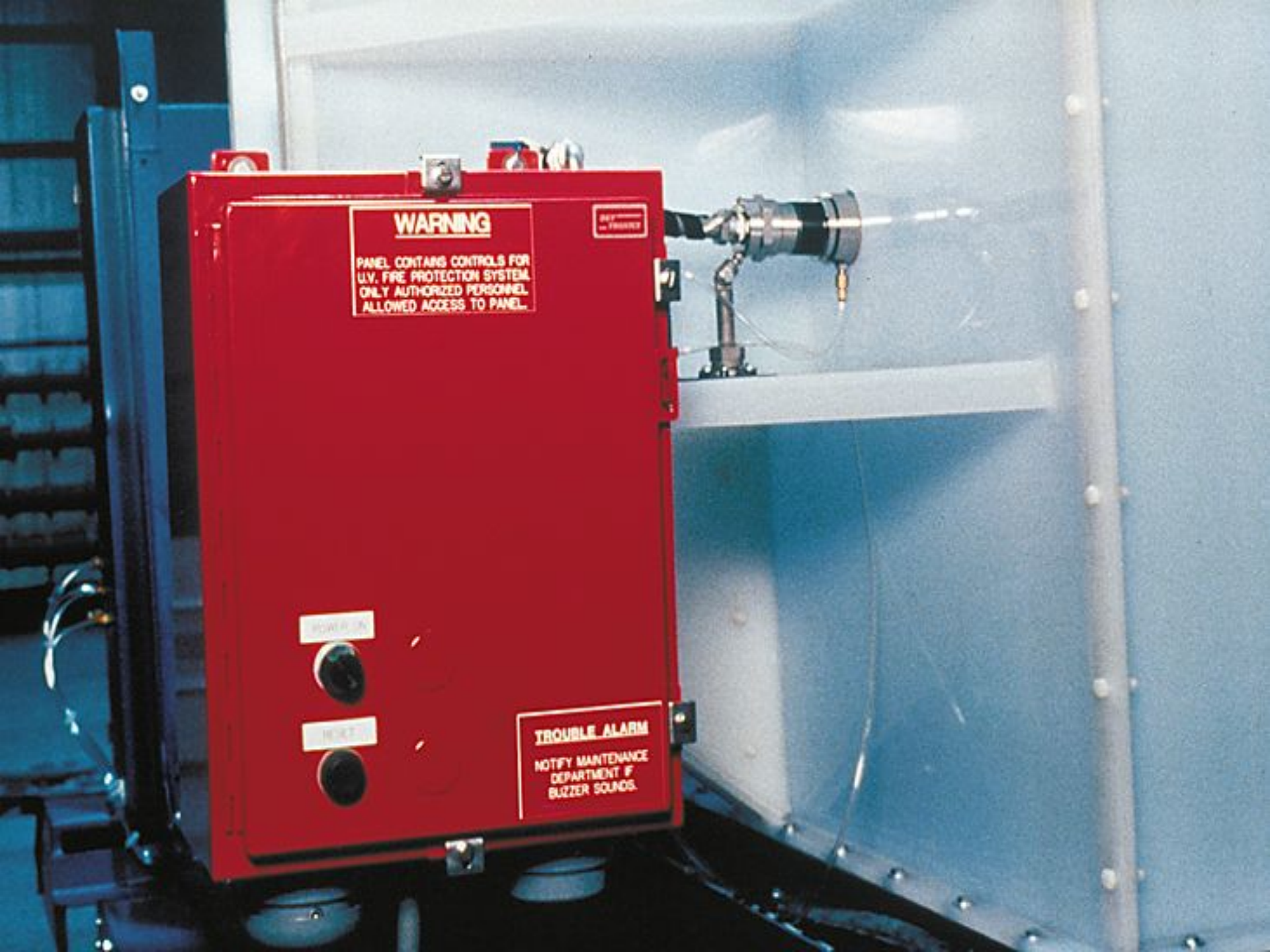
OSHA MATERIAL SAFETY DATA SHEET

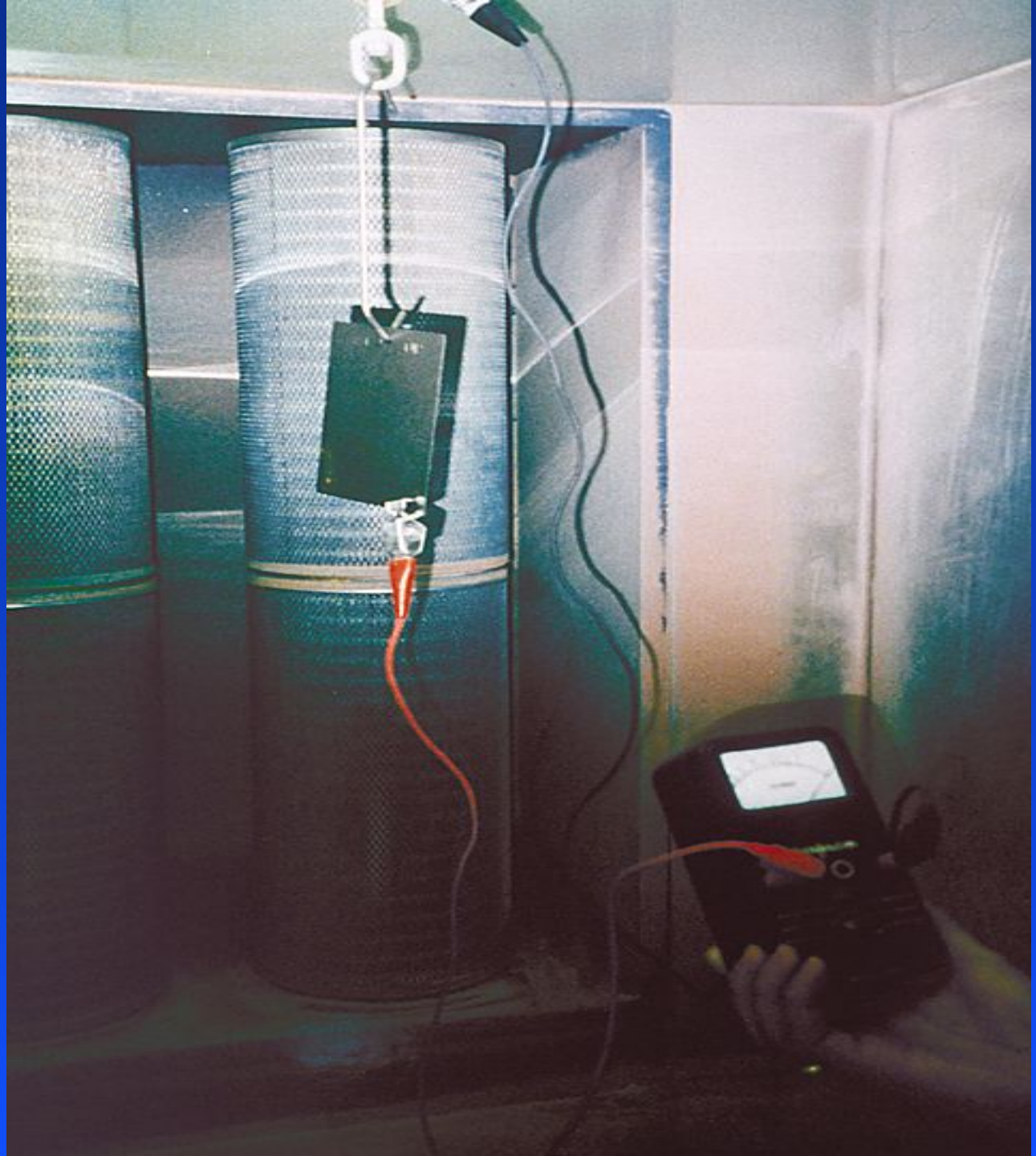
Chemical manufacturers shall obtain or develop a Material Safety Data Sheet for each hazardous chemical they produce. It must contain the following information:

- IDENTITY OF PRODUCT
  - Single Substance
    - Chemical/common name of hazardous chemical.
  - Mixture Tested As A Whole
    - Chemical/common name of mixture and chemical/common name of ingredients which contribute to hazard.
  - Mixture - Not Tested As A Whole
    - The chemical/common name(s) of all ingredients which have been determined to be health hazards and which comprise 1% or greater of the composition; chemicals identified as carcinogens if they are present at 0.1% or greater.
- PHYSICAL & CHEMICAL CHARACTERISTICS (VAPOR PRESSURE, FLASH POINT, ETC.)
- PHYSICAL HAZARDS INCLUDING POTENTIAL FOR FIRE, EXPLOSION, AND REACTIVITY
- HEALTH HAZARDS INCLUDING SIGNS & SYMPTOMS OF EXPOSURE AND ANY MEDICAL CONDITIONS WHICH ARE GENERALLY RECOGNIZED AS BEING AGGRAVATED BY EXPOSURE TO THE CHEMICAL
- PRIMARY ROUTE(S) OF ENTRY
- OSHA, PEL, ACGIH THRESHOLD LIMIT VALUE OR OTHER RECOMMENDED EXPOSURE LIMITS
- A DETERMINATION THAT THE CHEMICAL IS LISTED (OR NOT) AS A CARCINOGEN BY IARC, NTP, OR OSHA
- GENERALLY APPLICABLE PRECAUTIONS FOR SAFE HANDLING
- GENERALLY APPLICABLE CONTROL MEASURES SUCH AS ENGINEERING CONTROLS, WORK PRACTICES OR PERSONAL PROTECTIVE EQUIPMENT
- EMERGENCY FIRST AID PROCEDURES
- DATE OF PREPARATION OF MATERIAL SAFETY DATA SHEET
- UPDATE AS REQUIRED

Fire Risk

- Maintain Safe Concentration Level of Powder
- Eliminate Sources of Ignition
- Maintain Good Ground of Everything in the System
- Maintain Good Ground Through Racks


WARNING
PANEL CONTAINS CONTROLS FOR U.V. FIRE PROTECTION SYSTEM. ONLY AUTHORIZED PERSONNEL ALLOWED ACCESS TO PANEL.
TROUBLE ALARM
NOTIFY MAINTENANCE DEPARTMENT IF BUZZER SOUNDS.



Pretreatment Chemicals

- Read MSDS
- Avoid Skin Contact
- Wear the Recommended Safety Clothing
- Maintain Good Ventilation

High Temperature Environments

- Limit Access
- Never Enter Washer or Oven During Operation
- Disconnect Power Before Entering
- Use Good Lighting When Entering
- Wear a Hard Hat in Areas Where it is Necessary to Stoop
- Know the Hazards Inside the Equipment


DANGER
DO NOT ENTER
EXTREME HEAT

For Safe Handling of Materials & Operation of Equipment

Always Follow the Manufacturers Written Procedures